EXCELLENCE WITH LEADERSHIP: THE CROWN INDICATOR OF *SCIMAGO INSTITUTIONS RANKINGS IBER REPORT*

Veljko Jeremić, Marina Jovanović-Milenković, Zoran Radojičić, and Milan Martić

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Veljko Jeremić is an assistant professor at the *Department of Operational Research and Statistics* at the *Faculty of Organizational Sciences*, *University of Belgrade*. He was born in 1985, finished his PhD thesis in the field of computational statistics in the 2012. He has published over 60 scientific papers with emphasis on *ISI* indexed journals (over 20 papers). He is co-author of one university textbook. He has acted as a reviewer for many *ISI* indexed journals such as: *Jasist*, *Scientometrics*, *Journal of applied statistics.*
http://orcid.org/0000-0002-7761-1841

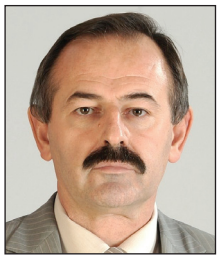
jeremic.veljko@fon.bg.ac.rs

Marina Jovanović-Milenković is an assistant professor at the *Department of Information Technologies* at the *Faculty of Organizational Sciences*, *University of Belgrade*. She was born in 1976, finished her PhD thesis in the field of information and communication technology in health care management in 2011. She published over 30 scientific papers with emphasis on *ISI* indexed journals (5 papers). She has participated in the organization of the doctoral degree study program *Management of the health system*. Her major interests are e-health, ICT implementations in health systems and business decision making.
http://orcid.org/0000-0003-3687-5282

marinaj@fon.bg.ac.rs

Zoran Radojičić is an associate professor at the *Department of Operational Research and Statistics* at the *Faculty of Organizational Sciences*, *University of Belgrade*. He defended his PhD thesis in the field of computational statistics in 2007. Main research interests include: statistics, applied statistics, social sciences and biostatistics. He has published over 40 papers at *SCI Thomson Reuters* database. He has participated in *Tempus* and numerous projects supported by the *Ministry of Science* of *Republic of Serbia*. He was included in international projects financed by *World Bank* and *EBRD* in the region.
http://orcid.org/0000-0002-1536-8591

radojicic.zoran@fon.bg.ac.rs



Milan Martić is a dean and full professor at the *Department of Operational Research and Statistics* at the *Faculty of Organizational Sciences*, *University of Belgrade*. He defended his PhD thesis in the field of operational research in 1999. He has published over 130 scientific papers with emphasis on *ISI* indexed journals (over 12 papers). He is co-author of seven university textbooks. He has acted as a reviewer for many *ISI* indexed journals. His major interests are data envelopment analysis, efficiency models and operational research.
http://orcid.org/0000-0002-0289-6678

martic.milan@fon.bg.ac.rs

University of Belgrade, *Faculty of Organizational Sciences*, Jove Ilica 154, 11000 Belgrade, Serbia

Abstract

Although there are many models for ranking higher education institutions, the *SCImago Institutions Rankings* methodology stands out for its ability to present quantitative and qualitative indicators of scientific output. Besides *Total number of published papers*, several indicators are concerned with quality dimensions of published papers, such as *International collaboration, Scientific leadership* or *High quality publications*. However, official rankings are provided solely on the basis of one indicator: *Output* (*total number of published papers*). This paper presents a statistical I-distance method that integrates all the indicators into one value, which therefore represent a rank and show which of the input indicators is the most important for the process of ranking. Our results clearly showed that *Excellence with Leadership* occupies the most significant spot.

Article received on 22-04-2013
Final acceptance: 01-07-2013

Keywords

Ranking of universities, I-distance method, *SCImago Institutions Rankings Iber reports*, Statistical methods.

Título: Excelencia con liderazgo: el indicador rey del *SCImago Institutions Rankings Iber report*

Resumen

Aunque hay muchos modelos para clasificar instituciones de educación superior, la metodología de *SCImago Institutions Rankings* destaca por su capacidad de presentar indicadores cuantitativos y cualitativos de la producción científica. Además del *Número total de artículos publicados*, varios indicadores se refieren a aspectos de calidad de los trabajos, como *Colaboración internacional*, *Liderazgo científico* o *Publicaciones de alta calidad*. Sin embargo, las clasificaciones oficiales se ofrecen únicamente en base a un indicador: *Resultados* (número total de artículos publicados). Este trabajo presenta el método de I-distancia estadística que integra todos los indicadores en un valor, lo que facilita el establecimiento de una lista o ranking, y muestra cuál de los indicadores es el más importante para el proceso de clasificación. Los resultados muestran claramente que *Excelencia con liderazgo* es el más influyente.

Palabras clave

Rankings de universidades, Método I-distancia, *SCImago Institutions Rankings Iber reports*, *SIR*, Métodos estadísticos.

Jeremić, Veljko; **Jovanović-Milenković, Marina**; **Radojičić, Zoran**; **Martić, Milan** (2013). "Excellence with Leadership: the crown indicator of *SCImago Institutions Rankings Iber report*". *El profesional de la información*, September-October, v. 22, n. 5, pp. 474-480.

http://dx.doi.org/10.3145/epi.2013.sep.13

1. Introduction

The increasing number of methodologies for ranking higher education institutions (HEI) has attracted many different stakeholders, especially students. Consequently, those rankings are quite often used as an indicator of a university's reputation and performance (**Agasisti**; **Pérez-Esparrells**, 2010; **Altbach**, 2013; **Bonaccorsi**; **Daraio**, 2008; **Bowman**; **Bastedo**, 2011; **Hazelkorn**, 2011; **Hien**, 2010; **Jeremić** *et al.*, 2011; **Marginson**, 2011; **Sadlak**, 1978; **Salmi**, 2003; **Torres-Salinas** *et al.*, 2011; **Usher**, 2012). Some argue that "University rankings are very appealing, in that they provide a single number that allows, at a glance, to situate a given university in the worldwide context. However, this very simplicity of use can be highly misleading in that most rankings are based on a simple formula that aggregate subjectively chosen indicators" (**Saisana**; **D'Hombres**, 2008). Almost certainly, the most cited ranking list is the *Academic Ranking of World Universities* (*ARWU*), which has been the focus of researchers (**Paruolo** *et al.*, 2013; **Saisana**; **D'Hombres**; **Saltelli**, 2011) since its first creation in 2003 (**Aguillo** *et al.*, 2010; **Dehon**; **McCathie**; **Verardi**, 2010; **Jovanović** *et al.*, 2012; **Docampo**, 2008, 2011; **Docampo** *et al*., 2012). Yet, almost immediately after the release of its first ranking, the *ARWU* attracted a great deal of criticism (**Docampo**, 2012, 2013; **Billaut**; **Bouyssou**; **Vincke**, 2010). One of the potential weaknesses frequently highlighted (**Nishy** *et al.*, 2012; **Prathap**, 2012a, 2013; **Radojičić**; **Jeremić**, 2012) is the absence of scientific quality indicators such as high quality papers (those ranked in the first quartile ~ 25% ~ in their categories), etc. Thus, the latest release of the *SCImago Institutions Rankings* (*SIR*) *Iber reports* (*SIR*, 2013), which quantifies the research performance of 1,600 leading research institutions of Ibero-American countries, brings even more to the table (**Prathap**, 2012b).

http://www.scimagoir.com

The *SIR* approach integrates one quantitative and various qualitative variables. The *Output* (O) indicator is a measure of the quantity of an institution's publication output. It represents the total number of documents published in scholarly journals indexed in Scopus (**Romo-Fernández** *et al.*, 2011).

Seven other variables represent the quality dimension of scientific output: *International collaboration* (*IC*), *Normalized impact* (*NI*), *High quality publications* (*Q1*), *Specialization in Research* (*Spec*), *Excellence rate* (*ER*), *Scientific leadership* (*Sla*) and *Excellence with leadership* (*Ewl*).

The *IC* variable represents an institution's output ratio produced in collaboration with foreign institutions. The values are computed by analyzing output with affiliations including more than one country address (**Guerrero-Bote**; **Olmeda-Gómez**; **De-Moya-Anegón**, 2013; **Lancho-Barrantes**; **Guerrero-Bote**; **De-Moya-Anegón**, 2013). However, the question raised is whether this characteristic actually provides insight into scientific output, since cooperation of Serbian and Montenegrin universities, for instance, is international while these countries were until recently one state union. Further, *NI* compares the average scientific impact of the institution with the world average (taken as 1). Thus, a score of 0.8 implies a performance 20% below average, whereas a score of 1.3 means the institution is considered 30% above average (**González-Pereira**; **Guerrero-Bote**; **De-Moya-Anegón**, 2010). One can argue that since "citation is counted only if it is made to an item published in the three previous years", some important citations have been excluded (**Getachew-Dinku**, 2011).

Also, Q1 is the ratio of publications that the institution publishes in what the *SCImago* team takes as the most influential scholarly journals of the world: those ranked in the first quartile (25%) in their categories as calculated by *SCImago*

Journal Rank. Since this is reported as a percentage, the ratio (Q1/25) is a crude normalized proxy for quality of publication, with a value of 1 taken as the world average (**Miguel**; **Chinchilla-Rodríguez**; **De-Moya-Anegón**, 2011). It is essential to mention that *SJR* doesn't include journals' self-cites (as done by *Thomson Reuters* IF) and the weight of citations depends upon the "prestige" of the citing journal (**Falagas** *et al.*, 2008).

The *SI* variable indicates the extent of thematic concentration/dispersion of an institution's scientific output. The values of this indicator range between 0 and 1, indicating more generalist or specialized institutions, respectively (**López-Illescas**; **De-Moya-Anegón**; **Moed**, 2011). On the other hand, *ER* indicates the percentage of an institution's scientific output that is included in the set formed by 10% of the most-cited papers in their respective scientific fields. This indicator serves as a measure of the high-quality output of research institutions. Again, the ratio *ER*/10 allows one to normalize this indicator so that the world average becomes 1 (**Bornmann**; **De-Moya-Anegón**; **Leydesdorff,** 2012). *Lead* indicates an institution's "output as main contributor", that is the number of papers in which the corresponding author belongs to the institution (**De-Moya-Anegón**, 2012). Finally, *Ewl* indicates the amount of documents in the *Excellence rate* in which the institution is the main contributor (*SIR*, 2013).

Nonetheless, although the *SIR Iber report* presents all the valuable data, the official rankings are presented based only on the number of *Total published papers* (indicator *Output - O*). Having said this, it is essential to provide a potential upgrade of current framework and create a synthesised indicator that will incorporate both the quantitative and qualitative dimensions of *SIR Iber report*. Further, it is vital to establish which of these dimensions provides better insight into scientific excellence of a HEI. As a possible remedy to the issue, the statistical I-distance method is elaborated and applied.

2. I-distance method

Quite frequently, the score obtained in a specific league list can seriously affect the process of taking exams, entering competitions, UN projects participation, medicine selection and many other areas (**Jeremić**; **Radojičić**, 2010; **Al-Lagilli** *et al.*, 2011). I-distance is a metric distance in an n-dimensional space. It was originally proposed and defined by Branislav Ivanović, and has appeared in various publications since 1963 (**Ivanović**, 1977). Ivanović devised this method to rank countries according to their level of development on the basis of several indicators; many socio-economic development indicators had been considered and the problem was how to use all of them in order to calculate a single synthetic indicator which would thereafter represent the rank.

For a selected set of variables $X^T=(X_1,X_2,...,X_k)$ chosen to characterize the entities, the I-distance between the two entities $e_r=(X_{1r},X_{2r},...X_{kr})$ and $e_s=(X_{1s},X_{2s},...X_{ks})$ is defined as

$$D(r,s)=\sum_{i=1}^{k}\frac{\left|d_i(r,s)\right|}{\sigma_i}\prod_{j=1}^{i-1}\left(1-r_{ji.12...j-1}\right)$$

where $d_i(r,s)$ is the distance between the values of variable X_i for e_r and e_s, e.g. the discriminate effect,

$$d_i(r,s)=x_{ir}-x_{is},\ i\in\{1,...,k\}$$

σ_i the standard deviation of X_i, and $r_{ji.12...j-1}$ is a partial coefficient of the correlation between X_i and X_j, ($j<i$), (**Bulajić** *et al.*, 2012; **Dobrota**; **Jeremić**; **Marković**, 2012).

The construction of the I-distance is iterative; it is calculated through the following steps:

- Calculate the value of the discriminate effect of the variable X_1 (the most significant variable, that which provides the largest amount of information on the phenomena that are to be ranked).
- Add the value of the discriminate effect of X_2 which is not covered by X_1
- Add the value of the discriminate effect of X_3 which is not covered by X_1 and X_2
- Repeat the procedure for all variables (**Jeremić** *et al.*, 2012; **Radojičić** *et al.*, 2012).

Sometimes, it is not possible to achieve the same sign mark for all variables in all sets, and, as a result, a negative correlation coefficient and a negative coefficient of partial correlation may occur (**Jeremić** *et al.*, 2011; **Maletić** *et al.*, 2012). This makes the use of the square I-distance even more desirable. The square I-distance is given as:

$$D^2(r,s)=\sum_{i=1}^{k}\frac{d_i^2(r,s)}{\sigma_i^2}\prod_{j=1}^{i-1}\left(1-r_{ji.12...j-1}^2\right)$$

In order to rank the entities (in this case, universities), it is necessary to have one entity fixed as a referent in the observing set using the I-distance methodology (**Jeremić** *et al.*, 2012; **Jovanović** *et al.*, 2012). The entity with the minimal value for each indicator or a fictive minimal entity should be utilized as the referent entity, as the ranking of the entities in the set is based on the calculated distance from the referent entity (**Seke** *et al.*, 2013).

3. Results of the I-distance method

For this study, the latest release of the *SCImago Institutions Rankings* (*SIR*) *Iber reports* (*SIR*, 2013) was analyzed. Out of the 1,600 leading research institutions ranked in the *SIR* 2013 *Iber reports*, 148 universities with the *Output* indicator larger than 1,000 papers were selected and the I-distance method was performed on that sub dataset. The results achieved by means of the squared I-distance method for the first 20 HEI are shown below in table 1 (full list is available upon request). The construction of the I-distance uses an iterative approach, and the crucial idea is to reduce the duplication of information. It is done by partially integrating the variables into the creation of one value which will therefore represent the rank. Particularly interesting is that variables with different types of measurements (percentages, GDP, student enrolment rate, etc.) could easily be integrated into one variable.

As can be seen from table 1, *Universidade de São Paulo* tops the I-distance method. This university has an impressive *Output* indicator, with 47,833 published papers. On the other hand, all the other indicators are solid but far from the best. One should note that the *Universitat Rovira i Virgili* is highly placed (2nd spot), although it has a rather small number of published papers – just 4,186 (less than 10% of *São Paulo*'s output). Precisely this information is crucial because it is essential to elaborate other variables in which the *Universitat Rovira i Virgili* impresses. For instance, in a quality indicator such as *Excellence with leadership* ~ *Ewl* (10.6) and *Excellence rate* ~ ER (17.17), the *Universitat Rovira i Virgili* is one of the best universities (number one concerning the indicator "*Excellence with leadership*", third in the "*Excellence rate*"). A similar conclusion has been noted by **Radojičić** & **Jeremić** (2012), for *Rockefeller University*, a postgraduate-only institution with a small number of published papers but fully impressive in quality indicators such as *Q1* (88.6%) and *ER* (48.8).

Consequently, it is essential to determine which of the eight input indicators is the most important for the process of ranking. Thus, this data set has been further examined and the correlation coefficients of each variable with the I-distance values have been determined. The results shown in table 2 demonstrate that the most significant variable for the calculated I-distance value is *Excellence with leadership* (*Ewl*), highly correlated with the I-distance value ($r = 0.676$, $p < 0.01$). *Total number of published papers* (*Output*), *Excellence rate* (*ER*), *Normalized impact* (*NI*) and *High quality publications* (*Q1*) are also very important indicators, with each correlation larger than 0.5 ($p < 0.01$). This finding clearly shows that the qualitative dimension of scientific output must not be neglected at any cost.

Table 1. Results of the squared I-distance method for HEI provided in *SIR 2013 Iber report* (first 20 placed HEI)

Rank	Higher education institution	State	I-distance
1	*Universidade de São Paulo*	BRA	90.858
2	*Universitat Rovira i Virgili*	ESP	45.542
3	*Universidad Politécnica de Valencia*	ESP	42.071
4	*Universitat de Lleida*	ESP	39.112
5	*Universidade de Vigo*	ESP	38.452
6	*Universitat Politècnica de Catalunya*	ESP	37.253
7	*Universitat Jaume I*	ESP	36.711
8	*Universidad Pública de Navarra*	ESP	34.533
9	*Universidad Carlos III de Madrid*	ESP	34.283
10	*Universidade do Minho*	PRT	34.034
11	*Universitat d'Alacant*	ESP	33.583
12	*Universidad Nacional del Litoral*	ARG	33.401
13	*Universidad Politécnica de Cartagena*	ESP	33.298
14	*Universitat de Barcelona*	ESP	33.035
15	*Universidad Técnica Federico Santa María*	CHL	32.803
16	*Universidad de Sevilla*	ESP	32.323
17	*Universidad de Castilla-La Mancha*	ESP	32.287
18	*Universitat de les Illes Balears*	ESP	32.052
19	*Universidade de Aveiro*	PRT	31.984
20	*Universidad de Zaragoza*	ESP	31.686

Table 2. The correlation between input variables and I-distance values

	I-distance
Excellence with leadership (Ewl)	0.676**
Output (O)	0.589**
Excellence rate (ER)	0.561**
Normalized impact (NI)	0.533**
High quality publications (Q1)	0.522**
Scientific lead (Lead)	0.444**
International collaboration (IC)	0.302*
Specialization index (SI)	0.286*

** $p < 0.01$, * $p < 0.05$

4. Concluding remarks

The increasing number of ranking methodologies used to identify the world's best universities is pushing the academic world into becoming even more concerned with the assessment of higher education. With these rankings often used as a marketing tool for universities to show their educational or research excellence, the need to provide rankings as accurate as possible becomes exceptionally important (**Radojičić**; **Jeremić**, 2012). The analysis presented here stresses potential improvements in the *SCImago Ranking* methodology, with emphasis on the quality indicator of universities' scientific output. The idea is consistent with the approach taken by **Torres-Salinas** *et al.* (2011), which presents the IFQ2A index as an integrated index of qualitative and quantitative scientific indicators. In addition, the *Leiden ranking* (Leiden, 2013) has some similarities with *SCImago* in terms of bibliometric data, and rankings focused on the research performance of institutions. However, in *Leiden ranking* the journals that do not have a strong international scope (i.e., not published in English or articles with authors concentrated in one or a few countries) or have a small number of references to other journals in the *Web of Science* database are being excluded from the analysis (**Waltman** *et al.*, 2012). Perhaps this could be a way to go for following *SIR* lists. Moreover, by default the *Leiden ranking* reports size-independent indicators (average statistics per publication, such as a university's average number of citations per publication). The advantage of size-independent indicators is that they enable comparisons between smaller and larger universities (Leiden, 2013). As an alternative to size-independent indicators, the *Leiden ranking* can also report size-dependent indicators, which provide overall statistics of the publications of a university (the total number of citations of the publications of a university). Size-dependent indicators are strongly influenced by the size of a university and therefore tend to be less useful for comparison purposes (**Waltman** *et al.*, 2012). Furthermore, our approach could contribute to the emerging efforts to map regions of academic excellence and scientific output (**Bornmann**; **Leydesdorff**, 2011; **Bornmann**; **Waltman**, 2011; **Prathap**, 2011). Additionally, I-distance methodology could embrace the postulates of bootstrapping and we hope to encourage potential researchers in this area.

Acknowledgment

The authors would like to thank the editor and anonymous reviewers for their valuable comments and suggestions, which significantly improved the quality of the paper.

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